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ON THE
VOLCANIC THEORY.

BY THE REV. WILLIAM RICHARDSON, D.D.
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COMMUNICATED BY THE RIGHT. REV. THE LORD BISHOP OF DROMORE.

READ, DEC. 10th, 1804.

PART I.

EXAMINATION OF MR. DESMAREST'S MEMOIR,

PUBLISHED IN THE TRANSACTIONS OF THE ACADEMY OF SCIENCES,
IN THE YEAR 1771.

> NAVEM SI POSCAT SIBI, PERONATUS ARATOR
> LUCIFERI RUDIS, EXCLAMAT MELICERTA, PERISSE
> FRONTEM DE REBUS.——

I BELIEVE I need not enter into any proof, that the theory, which makes Basalt a volcanic production, and once fluid lava, was invented by Mr. Desmarest; the friends, as well as the enemies, of this opinion, are unanimous in ascribing it to him alone. Dr. Hamilton (Lett. I. Part II.) calls him, the ingenious father of the Volcanic Theory; and Mr. Raspe says, "if it deserves any praise to have first "hit on a lucky hypothesis, it cannot possibly be denied to "Mr. Desmarest;" and Mr. Kirwan, while he combats the opinion, calls Mr. Desmarest, the father of the Volcanic Theory.

In discussing a philosophical question, it may not, at first view, seem very important, to determine with whom the opinion originated; but Mr. Locke tells us, that, in the case of propositions whereof we have no certainty, but only some inducements to receive them for true, the grounds of probability are to be considered; and, where the question turns on the testimony of others, we are to look to the number, the integrity, the skill, of the witnesses, and the design of the author, if it be a book, &c.

Now, I have shewn already, from the letter, of which Mr. Desmarest himself was bearer,* that his design, in making observations in natural history, was to enable him to combat the account, given by Moses, of the creation of the world, particularly in its date.—I do not mean to avail myself any farther, of this discovery of Mr. Desmarest's intentions, than as an excuse for examining his Memoir with more minuteness, than it is probable I would otherwise have done; and, also, for cautioning those who read it, to be on their guard against the statements of an *ex parte* writer.—If the merit of an author is to be estimated by the success of his work, I do not know any man, who, in this point of view, can compare with Mr. Desmarest. He made, as he says, a discovery in natural history, which had hitherto escaped the most penetrating philosophers. He published a new theory, and the world instantly adopted his opinions; and with such zeal, that we find many respectable writers, of the time, catch at opportunities (even out of their way) to express their approbation of them.

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* It is to the following tenor:—" This letter, my dear companion, will be " delivered to you by Desmarest, a man of merit and sound philosophy, who " wishes to pay his respects to you, on his journey to Italy, where he *purposes* " *to make such observations in natural history, as may very well give the lie to* " *Moses.* He will not say a word of this to the master of the Sacred Palace, but " if, perchance, he should discover, that the world is more ancient than even " the Septuagint pretend, he will not keep it a secret from you." (Lettr. 137. An. 1763, as quoted by Baruel, Memoires de Jacobinisme, Tom. I. p. 151.)

It is a bold undertaking to convince the world, that it has been in the wrong; nor can I expect a favourable reception,

Dum veteres avias tibi de pulmone revello:

and the rather, as I have a double task to perform; for I must not only shew, that Mr. Desmarest's opinions are perfectly unfounded, but I have also to account for their miraculous propagation.

In this latter part, I have the assistance of the same person, who discovered to us Mr. Desmarest's original intention, Abbé Barruel; who states, that, at the time the Memoir was published, upon which the whole theory rests, (1771), the public opinion, in philosophical matters, was very much governed by the authority of the Academy of Sciences; the leading members of which were all Mr. Desmarest's associates in his hostility to Moses, and in pursuit of the same end (the extirpation of Christianity); that they countenanced, or rather puffed, all opinions which they (being in the confidence of the authors) knew had a tendency to favour their grand object.

This charge, against so respectable a body as the Academy of Sciences, is, I admit, too general; especially as it is made by an author of decided partiality. It, therefore, requires some more direct proof to establish it, and from a less suspected source. Such evidence, I apprehend, will be readily found, and in the Transactions of the Academy itself.

In general, when a memoir was approved, and published by that Society, a precis, or abridgment of it, was prefixed at the beginning of the volume. This was the business of an officer, called the Historian of the Academy: of course, while the memoir rested upon the authority of its author alone, the precis had the sanction of the Academy itself, which took this method of announcing to the world, the opinion that body entertained on the subject.

Two passages, in the precis of Mr. Demarest's Memoir, mark the zeal with which the Academy took up this question; and prove, that its members were as little scrupulous, as Mr. Demarest himself, about the means they made use of, to support a favourite opinion, which they were told, by its author, would be useful in furthering their grand scheme.

In this precis, the Historiographer of the Academy makes two assertions, obviously decisive, on the question, if admitted to be true: he says,

"Almost every where, basalt is found mixed with scoria;" and "all known volcanos are accompanied by masses "of basalt."

After two such clear and positive assertions, so conclusive to the point, and from such authority, it is not surprizing, that the world should implicitly adopt an opinion so effectually supported.

But, as Mr. Desmarest's object in inventing this theory, the tendency of his opinions, and the use to which he meant to apply them, are now fortunately discovered, I hope to be excused, for requesting the public to rally a little, and to examine into the truth of these positions of the Academy, that have, no doubt, contributed much to accredit the theory, which ascribes to basalt a volcanic origin.

As to the first, that *basalt is almost every where found mixed with scoria,* the obvious mode of ascertaining its truth seems to be, an examination of the accounts, given by respectable writers, of different countries, where basalt has been found; and I begin with Egypt, where it seems to have been first noticed.

Egypt has never been supposed a volcanic country; nor does the place, where Strabo found basalt, bear any marks of the irregularity of surface, the necessary effect of volcanic eruptions; for Strabo describes it as a level plain, through which he drove in a chariot. Mr. Desmarest himself, who must have been well acquainted with volcanic countries, is so little pleased with this account of Strabo's, that, notwithstanding his known accuracy, he endeavours to invalidate his testimony, on the authority of Norden and Pococke. Still, however, the scoria of the Academy escapes them all.

The next place I shall mention, is Haut Vivarois, described, by Mr. St. Fond, as an extensive basalt country, reaching all the way to the Loire, abounding wish basalt mountains of great elevation, *buttes isoleés*, and articulated prisms: but he expressly tells us, that the volcanic features and productions have all disappeared; lavas or scoriæ are never mentioned.

Mr. Dolomieu, another sanguine advocate for the volcanic origin of basalt, and also a friend of Mr. Desmarest, was much surprised, when he found Lisbon situated in a basaltic country, without a single volcanic feature, or production; no scoria, as he expressly tells us.

The late Dr. Gillan, who accompanied the Chinese embassy, seems to have paid great attention to volcanic matters, wherever he met with them; yet, when he found columnar basalt at Rio Janeiro, he neither mentions scoria, nor any other volcanic production.

Sir Joseph Banks gives us a most excellent account of the basaltic island of Staffa, with its magnificent colonnades, and neat prisms; yet he does not mention a single volcanic matter; and I can scarcely think, that scoria would have escaped so accurate an observer.

Mr. Ferber, Mr. Strange, and Mr. Saussure, tell us of columnar basalt in the Veronese and Vicentin, but take no notice of any scoria.

Mr. Ferber, also, gives a particular account of different varieties of basalt at Bolsena, but looks in vain for volcanic features. The crater is gone, or buried in the lake, as he conjectures, and no mention of scoria.

I add, to the countries abounding with basalt in columns, among which scoria is not found, the county of Antrim, which I have carefully examined.

The Historian of the Academy is not more fortunate in his second position on this subject, though he puts it with more confidence, and more generally. He says, "*all* "*known volcanos are accompanied by masses of basalt.*"

The reader will scarcely expect, that it is to the friends of Mr. Desmarest, and to the advocates for the volcanic origin of basalt alone, I will have recourse, for the contradiction of this unfounded assertion.

Mr. Strange, our resident at Venice, at the time this theory came in fashion, publishes a geological letter in Viaggi di Tozzetti, in which he says, "basalt prisms are "admitted, *da piu bravi chimici et fisici moderni*, to be "volcanic crystallizations;" and that such pillars have been discovered in the Veronese, in the Euganean Hills, and also above Valdagno; whence he expresses some surprise, that these prisms should be, as it were, peculiar to the Venetian territory; in the rest of Italy found at Bolsena alone; and not at all in the Kingdom of Naples, *though abounding with so many volcanic phænomena.*

The next authority I shall quote, in contradiction to this general assertion, is that of Sir William Hamilton; who lets no opportunity escape him, of proving his attachment to Mr. Desmarest's theory. Our Baronet had examined Vesuvius more frequently, and with more care, than any other person ever did; and, not finding any basalt upon it, thinks it necessary to account for a fact so hostile to his favourite theory. He says, " *the basalts were " all carried off from Vesuvius, to make Roman roads.*"

I will not presume to comment on the conjecture of so zealous a naturalist; and, as he establishes for me the total want of basalt, on this theatre of his repeated observations, I will, in my turn, admit, that he accounts satisfactorily for its disappearance from this volcano.

But the same conjecture will not account for the want of basalt, at the volcanos of Madeira, Teneriff, or the Isle of Amsterdam, which Dr. Gillan examined carefully, without noticing a particle of basalt.

The late Mr. Forster accompanied Captain Cook in his second voyage, undertaken soon after the publication of Mr. Desmarest's Memoir, and avows his adoption of the volcanic theory; yet, though Mr. Forster paid the greatest attention, both to basalt, and volcanic productions, he appears never to have found them together in the same place. His testimony bears directly against the confident position of the Academy; for he found undeniable marks, that proved the existence of former volcanos, at St. Jago, at Huaheine, at Bolabola, at Ulietea, at Easter-island, at the Marquesas, at St. Helena, and at Ascension-island. He also found volcanos, actually burning, at Tanna, and at Ambrymm; but at not one of these places does he take notice of any basalt. Yet his observations at Otaheite and New Zealand, shew, that he was well acquainted with it; and, from his having, for a time, mistaken trees for basalt pillars, he shews the subject was much in his thoughts.

It would be tiresome to lead the reader about the world, naming the different volcanos, scattered over its surface, where a particle of basalt has never been noticed. I have already given him sufficient materials, to enable him to form a judgment of the fairness with which the Academy of Sciences ushers in Mr. Desmarest's Memoir. The world will no longer be at a loss to account for the rapid success this theory has had. It can judge now, with what a prepossession, in its favour, a reader will pass from the *Precis* to the *Memoir*, when he finds its object is to prove, that there is an actual connection between certain productions of nature, which he has, the moment before, been assured, from the highest authority, are invariably found together.

But it is not by the weight of authority, nor the precipitate assent of the public, that our judgment should be regulated on philosophical subjects; nor because Mr. Desmarest's intentions have been discovered, to be hostile to what we have been used to respect, are we, therefore, at once, to condemn his opinions. Let us temperately examine his Memoir, and try, whether it be entitled to the credit it has obtained. Here I must request the reader to observe, that it is not the merits of the Volcanic Theory I am, at present, proceeding to discuss; but simply those of Mr. Desmarest's Memoir, admitted, on all sides, to be the basis upon which the Volcanic Theory rests. If this shall be found insufficient to sustain it, I will next examine, what support it receives from its other numerous and zealous advocates; and then I will proceed to try, whether this opinion be reconcileable, or not, to the facts in my own basaltic country

MR. DESMAREST'S MEMOIR.

Mr. Desmarest states, that, as he travelled through the mountains of Auvergne, he examined the extinguished volcanos, of which that country is full; and found, that currents of lava had issued from them in such abundance, as to cover a district eight or nine leagues in diameter. He gives us a map of this district, and affects to trace the several currents upon it, with great accuracy.

He observed, that when these currents were broken by mountain torrents, or other causes, the perpendicular face, so laid bare, was often composed of prismatic pillars, generally articulated, and exactly like those of the Giant's Causeway, in Ireland.

He tells us, also, that he has traced these currents up to the crater itself.

From the situations and circumstances, under which Mr. Desmarest found these pillars, he infers, they were formed by the fluid lava assuming these shapes as it cooled.

Such are the observations and inference, upon which the whole theory of the volcanic origin of basalt is founded; and it is plain, that, if what Mr. Desmarest pronounces to be currents of lava, are proved to be actually such, his conclusion is irresistible.

The question at issue, is thus reduced to a mere point. Were *these* currents of lava? or were they not?

On a former occasion, I had the hardihood to differ from Mr. Dolomieu, on the subject of the basalts of Sicily, which I had never seen; and attempted to prove, from *his own* facts and admissions, that what he pronounced to be currents of lava, had never flowed from any volcano. (Bibliotheque Britannique, No. 144.)

A similar attempt, in the case of Mr. Desmarest, will, I hope, be deemed more excusable, for two reasons; the first, that he himself has set me the example, by discussing the features, and products, of my country, which he, also, has never visited.

The second, that, as Mr. Desmarest, on the spot, confesses *his* doubts, and hesitates about pronouncing on his currents of lava; I hope I too may be forgiven for having *my* doubts, and that I shall be excused for examining these facts, which, it will appear, staggered himself.

The first seems to have been, *the solitary masses of basalt*, which he found in great abundance; for he admits, had these been all, he never could have pronounced basalt to be lava.

He is again puzzled, and confesses, that often he cannot find the volcano itself, at the upper extremity of the current which issued from it.

But the fact, which seems to have embarrassed him most of all, was, the groupes of pillars he found standing vertical on the summits of hills. These, he confesses, cost him much reflection, before he could account for them; which he does, at last, by considering the *suite of degradations*, and the *decomposition*, by which so many materials had been carried off.

I must confess, it is not surprising, that Mr. Desmarest should be much puzzled at finding a material, which, according to his theory, must have been in an high state of fluidity, settling itself on the summits of hills: yet this is a situation, for which columnar basalt seems to have a strong predilection, as well in Vivarois, and the North of Ireland, as in Auvergne.

These difficulties, Mr. Desmarest has been able to get over, at least, to his own satisfaction, without giving up his theory. With others, he is not equally fortunate: he tells us, page 720, that he found prismatic masses, *qui ne tiennent a rien*, which, by their disposition, exclude all correspondence with currents of lava, or with volcanos. These, he says, we are under the necessity of supposing, *were fused and cooled on the spot.*

Here Mr. Desmarest admits, that his theory does not account for the formation of *all* columnar basalts. Some, he confesses, are out of the reach of volcanos; and he is under the necessity of inventing a new operation of nature for the purpose. And, since it is plain, on inspection, that fluid lava could not have travelled to the place where he found these basalts, he is obliged to fuse something, on the spot, for his purpose; without condescending to give us the slightest account of these *new* and *occasional fires*, or of any circumstance attending them.

Mr. Desmarest's induction in this case, and which is perpetually adopted by those of his school, is short and clear.

He first *assumes*, that basalt is the effect of igneous fusion; and then it must be granted to him, that he may model these fires, so as to answer the end.

His successors have, in stating this argument, a great advantage over Mr. Desmarest; for, while he is obliged to get over his whole difficulty, by one grand postulate, they have the benefit of his authority; and quote him, like another Aristotle, *ipse dixit.*

A new difficulty occurred to Mr. Desmarest, which he does not avow, until he publishes his second Memoir. No doubt, emboldened by the great success of his first, he now discovers, that his theory cannot be overturned by any facts, however hostile to it; and, that his credit is so well established, that the world will implicitly receive any reason, he shall think proper to assign, for the most anomalous facts.

He found, as he admits, horizontal strata (couches) of argil and limestone, incumbent on his basaltic lavas. These materials are not volcanic productions; yet Mr. Desmarest must account for their being found in this unexpected situation, which he does, lightly and easily. He says, "*these are* "*(pour ainsi dire) a superfœtation, posterior to the lavas:*" that is, he throws *alma mater tellus* into labour again, delivers her of two or three strata; which, happening to be placed over his lavas, fully account for every thing.

With this ingenious and philosophical solution of his last difficulty, Mr. Desmarest completes the sum of the arguments,

ments, and evidence, which Auvergne affords, to enable him to establish his discovery, that columnar basalt is a volcanic production, formed in currents of lava as they cooled.

Fortunately, however, for *science*, and, I may say, for *truth*, Mr. Desmarest is not the only naturalist who has visited Auvergne, and published an account of its natural history. Mr. Guetard, a professed mineralogist, twice made a tour of Auvergne; and, with an interval of eight years, twice he published his observations, in the same Transactions with Mr. Desmarest. Should, therefore, any contradictions occur between these two gentlemen, the reader must decide between them as he best can: and, the better to enable him, I remind him, that, while Mr. Guetard seems to have no other views, but what are purely scientific; Mr. Desmarest has discovered his intention, of making natural history subservient to his purposes.

The Volcanic Theory, as laid down, and maintained, by Mr. Desmarest, I have shewn before, turns entirely on one question, to wit, whether what he pronounces to be currents of lava, actually flowed from any volcano? I, therefore, in comparing Mr. Guetard's account of the same country with his, shall limit myself merely to such facts and observations, as promise to throw light on this question.

Mr. Guetard visited Auvergne in 1752, and again in 1760. He piques himself on discovering this country to have been, at a remote period, ravaged by subterraneous fires and eruptions. His attention seems much fixed on volcanic objects: yet, in both tours, all these currents of lava escaped him; which, by Mr. Demarest's account, covered a district of country, eight or nine leagues in diameter.

This negative evidence, against Mr. Desmarest's currents of lava, is pretty strong: but Mr. Guetard is so good, as also to furnish us with positive evidence, direct to the point; for he assures us, Volvic alone, of all the extinguished volcanos in Auvergne, produced lavas in any considerable quantity; the others, to not more than the thickness of a few inches; their ejections consisting merely of scoria, cinders, pumices, and ashes.

Mr. Guetard, also, gives (quite incidentally) a most important *fact*, decisive as to these currents of lava, to wit, *the diameters of the craters;* the greatest of which measured but from five to six toises (from 30 to 36 feet); yet, if we believe what Mr. Desmarest calls currents of lava, to have been actually such, we must allow, that it was through these diminutive funnels such mighty torrents issued; and, in particular, the current, that formed the facade of Ladabraise, one hundred feet high. This I select, not as the greatest, but because Mr. Desmarest says, it issued at one jet.*

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* Though Mr. Desmarest, who, on his mission, had visited the Italian and Sicilian volcanos, often mentions the *craters*, from which his currents of lava issued, he carefully suppresses their dimensions; the difference between which, and those of other volcanos, known to have produced currents of lava, must instantly have struck every reader acquainted with such subjects. Sir William Hamilton informs us, that the crater of Etna was two miles and a half in circumference; that

In one point, these gentlemen are entirely agreed; that is, in their account of the Volvic lava, which Mr. Desmarest allows to be quite different from his basaltic lava, in its neighbourhood, but perfectly resembling the Vesuvian lava, full of pores, and breaking in all directions, *(casse en tout sens;)* while his own prismatic lava was quite compact, and so refractory, in the hands of masons, that the natives, who had a name of their own for it, *pierre d'eragne*, and were well acquainted with its inutility, instantly forsook a quarry, when they found the stone of this species.

Thus, by Mr. Desmarest's account, the volcanos of Auvergne produced two sorts of lava, quite different from each other. The first, exactly like the lavas of all other volcanos; the second, totally different: in *texture*, as being quite compact; in *form*, as being shaped into pillars and prisms; and in *fracture*, as disobedient to the tool of the workman.

Mr. Guetard's account is more simple. He tells us, the volcanos of Auvergne produced but one species of lava, and that exactly like all other lavas.

Should the reader be embarrassed by the contradictions of these gentlemen; the testimony of an author, who lived, at the

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that of Vesuvius, half a mile. Sir William thinks, that the craters of *extinguished* volcanos increase in size; and, accordingly, Bracini found, before the eruption of 1531, after an interval of rest of 492 years, that the circumference of the crater of Vesuvius was then five miles.

Sir William adds, that the craters of the extinguished volcanos, of Astruni and Monte Gauro, were six miles; while the smallest crater he mentions, is that of Monte Nuovo, which was but a quarter of a mile. This mountain, however, was thrown up in one night.

the time of the eruptions, in Auvergne, will, probably, throw light on the question, and enable him to decide between them.

Sidonius Apollinaris, Bishop of Clermont, in Auvergne, in the fifth century, describing the calamities of his country, to which he was witness, says:

" The mountains vomited out fire; their height was in-
" creased, by the quantity of burnt matters they threw
" up, and which, as they fell, heaped upon one another:
" the wild beasts fled into the towns for shelter."

We cannot have a more accurate description of Mr. Guetard's mountains, composed of scoria, cinders, pumices, and ashes; but not one word of Mr. Desmarest's currents of lava, which, by his account, covered a district, eight or nine leagues in diameter; and mighty torrents of liquid fire would have heightened Sidonius's picture, who appears disposed to be turgid.

Mr. Desmarest seems to have suspected, that the observations he made upon Auvergne, alone, were not sufficient to establish his discovery, that basalt prisms were a volcanic production. He must call in the aid of some other country, and shew, that in it, also, basalt was produced by subterranean fire.

He selected our county of Antrim for his purpose; a country he had not visited, and whose basaltic wonders, though even then much celebrated, had never been examined with care; nor was any tolerable account of them, at that time, published. Besides, one point alone (the Giant's Causeway itself) had been dwelt upon; whereas, it ought to be, from the general construction of the country, and the circumstances attending its basalts, that arguments were to be sought, to establish a decided resemblance between Antrim and Auvergne, in order to lead to the conclusion he wishes to draw; to wit, that Antrim also was a volcanic country.

Two views of the Giant's Causeway, published by Mrs. Drury, supplied the defect of other materials.

The first argument he drew from these views was, that, as they exhibit our Causeway, standing at the foot of a conical mountain, this must have been the volcano, whence the current of lava issued, in which it was formed.

Dr. Hamilton takes pains to shew, that Mr. Desmarest was misled in this point; which I would willingly allow, if it was the only instance in which he misrepresents our facts: but, as, in every step he takes, he endeavours to *mislead*, I will not precipitately acquit him, of the same intention, in this instance.

His next argument, to prove Antrim to be a volcanic country, is, from a resemblance, he thinks he discovers, between the valleys of Mont d'Or, in Auvergne, and, what he considers as, the skirts of mountains, in Mrs. Drury's drawings.

I must confess, I cannot discover any resemblance, between the faces of our precipices, in these drawings, and mountain valleys;* nor do I conceive a resemblance, between the skirts of mountains, in distant countries, (even if better established,) to be a fact of such importance, as to warrant a general conclusion of their similarity, in all other respects.

It is amusing to observe, with what force Mr. Desmarest puts this argument; how well satisfied he is with the *vis consequentiæ*, and to what an extent he avails himself of it. He says, " je tirai de cette conformité reconnue, une con-
" sequence, que la force de l'analogie m' autorisoit a tirer.
" Cette consequence me fit voir dans la Chaussee de Geans,
" et dans toutes les masses prismatiques, qui se montrent
" sur les bordes escarpeés de la mer, en Irlande, en un mot,
" dans les sommets tronqueés, q'on y appercoit, l'ouvrage
" des eruptions, d'un ou des plusieurs volcans, qui se sont
" eteints, comme ceux d'Auvergne."

I must make two observations on this passage. The first, that Mr. Desmarest calls this fanciful resemblance (he thinks he has discovered) *une conformité reconnue*, as if known and admitted by all the world.

The second, that he takes this opportunity of sliding in a most important fact, *sommets tronqueés*, truncated summits or cones, being one of the most characteristic features of volcanic countries; of course, when found in Antrim,

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* Since I wrote the above, I have carefully examined Mrs. Drury's drawings, which represent our uniform façades with great accuracy. No *valleys* or ravines, either in nature or the drawing, nor any thing like the skirts of a mountain.

decisive on what Mr. Desmarest labours to prove, to wit, that it was once the seat of volcanic eruptions.

Thirty pages afterwards, he resumes the topic; and, complaining of the English writers, for giving no account of the form of the mountain, at the foot of which the Giant's Causeway is placed, Mr. Desmarest kindly supplies their deficiency, and tells us, it is *une cone tronquée.*

Now, as there is nothing in Mrs. Drury's views, which can be tortured, by the warmest imagination, into a truncated cone; nor, in the vicinity of the Giant's Causeway, any feature of the slightest resemblance to it; and, as Mr. Desmarest himself admits, that none of the English writers mention the shape of these mountains, it becomes necessary to ask, where did he meet with this truncated cone, this decided volcanic feature, that helps him to establish his resemblance, between Antrim and Auvergne?

Mr. Desmarest was not aware, that, even in his own time, his intention, " *to make such observations in natural history, as* " *would very well enable him to give the lie to Moses,*" would be in possession of the public; or he probably would have been more cautious, how he exposed himself to a retort from any of Moses's friends;

Στρεπτη γὰρ γλωσσ' ἐστι βροτων πολεες δ' ἐνι μυθοι,
Οπποιον κ' ἐιπησθα επος τοιον κ' ἐπακουσαις.

Glib runs the tongue, with words unnumber'd fraught,
And gives you back as good as you have brought.

But, as I perceive, from the late publications in the National Institute, that Mr. Desmarest still wields his pen, I trust he will explain.

All that remained, to enable Mr. Desmarest to complete his proof, of Antrim being a volcanic country, was, to find the scoria, which, he well knew, was admitted, by all naturalists, invariably to accompany every volcano. Not one English writer, on the subject of the Giant's Causeway, had mentioned the word scoria: but Mr. Desmarest assures us, that their not having mentioned the scoria, along our coast and precipices, was pure omission; and, as to the scoria, that ought to have been found on the Giant's Causeway itself, it was (as he tells us) all washed off by the breach of the sea.

As Mr. Desmarest has been pleased to give us so much information, about our county of Antrim, which he never saw; I think the least I can do is, to return the obligation, and give him some information, relative to his Auvergne, which I have never visited.

I, therefore, venture to assure him, that Auvergne was, originally, a basaltic country; with its materials, arranged by the hand of nature, precisely in the same manner, as they are in Antrim, and, I believe, in all basaltic countries: that is, in extensive strata, horizontal, or nearly so; exhibiting flat terraces, accumulated upon each other, in several tier; often abrupted into perpendicular façades, displaying the prismatic and columnar construction of the basalt, of which they are composed; and that some of these strata are (as with us) often red or ochreous.

That this was the original construction of Auvergne, I rest upon the authority of Mr. Desmarest's own Memoir; where the corresponding circumstances of the two countries are detailed, in a manner not to be mistaken. For instance, he tells us, page 706, that his prisms rest upon a stratum of *terres cuites*, as our own often do upon an ochreous stratum, strongly resembling *baked earth*, or brick.

Page 730, he says, the strata form *plusieurs etages, ou ranges horizontales:* and again, page 737, the same words recur. Page 730, *terraces assez étendues*, platforms and terraces, perpetually occur; and the perpendicular façades, common to all basaltic countries, are to be met with, as well as his *terres cuites*, in almost every page.

From this account of Mr. Desmarest, it is plain, that the original materials and stratification, of Antrim and Auvergne, were precisely similar: but we have had the good fortune to remain undisturbed, while Auvergne has been ravaged by destructive eruptions. One at Volvic, more tremendous than the rest, poured forth vast torrents of lava; while the others, more diminutive, emitted only lighter materials, scoria, cinders, pumices, and ashes.*

Mr. Strange (whose adoption of Mr. Desmarest's theory I have proved before, by a quotation from his geological letter to Tozzetti) was much astonished, when he came to visit Auvergne, that, in no one instance, he found prismatic basalt near to any of the volcanos: a fact, which seems to have much weakened his belief in the Volcanic Theory.

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* These latter were, probably, some of the eruptions, to which Sidonius Apollinaris was witness; while, in all likelihood, the great eruption of Volvic happened at an earlier period.

No doubt, it must have appeared very extraordinary to him, that no connection or continuity was to be found, between *cause* and *effect;* between the volcano, and the lava that had issued from it. Mr. Desmarest, aware of this objection to his theory, anticipates it; and undertakes to account for this extraordinary circumstance. He tells us, that it is only at a great distance from their craters, that the currents of lava are able to disentangle themselves from the scorified matters.

This important fact, of the constant remoteness of the basalt from the volcanos, thus fully established, by the testimony both of Mr. Desmarest and Mr. Strange, is not very difficult to account for; as the volcanic ejections must, in every instance, have covered the original basalts, in the vicinity of the craters, so that the remote ones only are left visible.

The reader is now able to form his judgment, upon the merits of this celebrated Memoir; and to determine whether, in his opinion, it ought to have had such weight with the world, as to procure so rapid and general an assent, to Mr. Desmarest's theory.

As this gentleman undertook to enlighten mankind, on basaltic subjects, it was, no doubt, supposed, he had made this fossil his peculiar study; for,

Publica lex hominum naturaque continet hoc fas,
Ut teneat vetitos inscitia debilis actus.

Yet, I am afraid, that, while, upon the credit of Mr. D'Alembert, we admit Mr. Desmarest to be *a man of merit and sound philosophy;* we must, upon his own evidence, convict him of being little acquainted with the fossil, upon the nature of which he undertook to instruct the world; and ignorant of the varieties of basalt, and the modes in which nature has been pleased to arrange it.

Men of genius, and warm imagination, have sometimes dashed rapidly into topics, with which they had not taken time to make themselves sufficiently acquainted. Thus, Mr. Desmarest, from his zeal to co-operate in the views of his friends, D'Alembert and Voltaire, may have hurried into his basaltic Memoir, before he had taken sufficient time to examine this fossil. But he has since had leisure enough. He saw the world, for thirty years, busied upon the basaltic topics he had thrown out to them: he alone gave himself no trouble on the subject; for, at the end of thirty years, he shews, that he is perfectly unacquainted with most of the circumstances attending basalt.

After this long interval, Mr. Desmarest resumes his pen, and publishes another Memoir, in the fourth volume of the National Institute, and now talks of basalt with authority. He there tells us (page 320), that basalt pillars are formed by *une retraite et le reserrement, equally applicable to desiccation.*

Again (page 230), he repeats the same common cause, *retraite et reserrement;* in one case, the effect of *desiccation;* in the other, of *refroidissement.*

I will not detain the reader, by shewing the folly of lumping two causes for the same effect, so totally different from each other, as desiccation and contraction: the one arising from evaporation; the other from that property, which all solid bodies seem to have, of expanding, and contracting, with heat and cold. Nor will I dwell on the utter insufficiency of either cause, to produce our exquisitely neat and regular pillars, and especially their highly finished articulations.

It is to Mr. Desmarest's total ignorance of the *facts,* attending this fossil, I call the attention of the reader: for each cause, to which he ascribes the formation of basalt pillars, necessarily supposes intervals between them. Every one knows, that, on desiccation, cracks and intervals are produced: and Mr. Desmarest himself (page 222), explaining the formation of basalt prisms, by the other process, contraction in cooling, says, " *leur faces sont le* " *resultat des fentes verticales.*"

But, unfortunately for Mr. Desmarest's credit, in basalt, there are no intervals, no *fentes,* between the prisms, or pillars: all are united together, into one solid mass, separable from each other; but it is by external causes alone, that they are actually separated. It is true, the pillars, in our façades, sometimes exhibit very small intervals, between which, as Sir Torbern Bergman says, the point of a knife can scarcely pass: but, even these are limited to the surface; and, probably, the effect of contraction, and dilatation, from the variation of temperature, in our atmosphere. For, as we quarry farther in, the mass soon becomes solid: even the surface itself is frequently without the slightest intervals between the prisms or pillars. I refer the naturalist to two points, where he can easily get access to the foot of the precipice; the S. E. point of Portmoon, and Grace Staple's Cave, at Carrickarade: in both places, the façade is neatly columnar and prismatic, and also completely solid.

As this want of intervals establishes, both the inadequacy of the causes, which Mr. Desmarest assigns, with so much confidence; and, also, proves his own total ignorance of basalt, in its natural state: I will mention two facts more, which must put this point past a doubt.

The first; that a fall of 200 feet has not been able to separate the prisms, composing the prismatic masses, which have fallen down the vast perpendicular precipice at Fair-head.

The second; that the hollows, on the surface of the Giant's Causeway, are as staunch as a bason, and hold the water, that collects on them, from rain, or the spray, until it evaporates; whereas, it would soon find a passage, through Mr. Desmarest's intervals, if such existed.

Though this gentleman has given us opportunities enough, of discovering his ignorance of a subject, upon which he has brought so much attention; I will trouble the reader but with one instance more.

He had told us (page 222), that the prisms are always vertical: and again, (page 231), he generalizes, and makes this not an accidental position, but a matter of necessity; assuring us, that, " *in lava, the result must be a vertical* " *prism.*"

Had Mr. Desmarest paid any attention to basalt, he would have known, there are different varieties of it, which directly contradict his rule, so dogmatically laid down: some varieties, in which the axes of the prisms are indifferent to all positions; while the stratum, in which they are placed, remains perfectly steady; the axes assuming different degrees of obliquity, at short distances, and sometimes undulating.

The prisms, too, of the basalt walls, commonly called *whynn dykes*, are always horizontal.

PART II.

EXAMINATION OF THE FACTS AND OPINIONS, GIVEN BY DIFFERENT ADVOCATES FOR THE VOLCANIC ORIGIN OF BASALT, WHO FOLLOWED MR. DESMAREST;

TO WIT,

MR. FAUJAS DE ST. FOND, MR. DOLOMIEU, MR. WHITEHURST, BISHOP TROLL, ABBE SPALANZANI, AND DR. HAMILTON.

UTINAM TAM FACILE VERA INVENIRE POSSEM, QUAM FALSA CONVINCERE. CICERO.

I HAVE, in the preceding account of Mr. Desmarest's Memoir, enabled the reader to form some judgment of its merit; and to determine, how far its author has succeeded in establishing his position, that basalt is a volcanic production.

The advocates for this opinion, no doubt, may say, that its truth does not rest *solely* on Mr. Desmarest's proofs; that the Volcanic Theory has many other advocates, who, perhaps, may support it more ably than its original inventor; and who may adduce new arguments and facts, which had escaped him: that, therefore, to judge fairly, it becomes necessary to examine, what other writers say in its favour; and to try what new lights they throw upon the subject.

It is very true, this theory has been taken up by many others, who shew an eagerness to express their approbation of it; but not one of them seems to think any further proof of it necessary, than what Mr. Desmarest has already given. Arguments, therefore, in support of this theory, are not to be found in their works, nor, indeed, many *facts* that apply to the question; but, in their stead, we shall find *postulates* in abundance; for, circumstances most frequently occur, hostile to the volcanic origin of basalt. These must be explained, and accounted for: the friends, therefore, of this opinion, are reduced to the necessity of making postulates, which will, probably, surprise the reader, and, I hope, will also afford him some entertainment.

Mr. Faujas de St. Fond is the most celebrated, as well as the most voluminous writer on the subject. That he considered the volcanic origin of basalt, as a question no longer at issue, but finally decided in the affirmative, appears from the words, with which he commences one of his treatises, "*Mineralogie des Volcans*." He begins thus: "*Le basalte est une veritable lave, qui a incontestablement* "*coulé*." After this debut, the reader will not expect, that Mr. St. Fond will be at the trouble of demonstrating, what he has already taken for granted. An examination, however, of his *facts* is necessary. One of them has been considered, by different writers, as quite conclusive on the question; and, no doubt, at first view, appears to give strong testimony in favour of this theory.

Mr. St. Fond describes the mountain De la Coupe, in Vivarois, as bearing undeniable marks, of having been once a great volcano; a vast crater, scoriæ, and burnt matters, in abundance. But, the important fact is, that a current of lava has (as Mr. St. Fond says) run down from this crater, and descended into the plain, where it has formed an extensive *pavè de geans;* and that prisms appear in the current, before it has quite reached the plain.

Now, *audi alteram partem.* A naturalist, quoted by Mr. Kirwan, assures us, that the mountain De la Coupe never was a volcano; and, that what Mr. St. Fond calls a current of lava, is merely a stripe of trapose matter, which happens to have been laid bare.

Here we have the contradiction direct; and one instance, of the many, from which it appears, that disputed points, in natural history, are now reduced to mere wars of assertion, upon which no reliance whatsoever can be placed. How, then, is an impartial inquirer to obtain truth, when he knows that, in the relations given by partial theorists, no respect is paid to it?

The only method I know, is to neglect the strong assertions, which betray the object of the writer; and to attend to the more minute, and apparently unimportant circumstances, which escape him. Let us try that mode, in the present instance; and, I suspect, we shall come at the truth.

When Mr. St. Fond (who wishes to make this mountain a volcano) talks of scoria, and vitrified matters, I consider him, as using the common-place language of all those, who are anxious to establish similar points; and such as we meet with, in most accounts of my own country, written by friends to the Volcanic Theory; though, in reality, no such substances are found in it.

But, when he incidentally mentions *laves torses*, lavas twisted like a rope, a decided volcanic accompaniment, though rarely noticed as such, I begin to believe him, and admit his mountain, De la Coupe, to be an extinguished volcano.

Again, when I find Mr. St. Fond, labouring to establish a current of lava, as descending from the crater of this mountain, and continuing its course down its side, until it reaches the plain; where, as he says, it forms a most superb Giant's Causeway, of vast height; this fact is so decidedly conclusive in his favour, that I begin to suspect him, and think it necessary to examine and compare the minute circumstances of his account; which soon turn out irreconcileable to its main object. For instance, he tells us, the whole country, from Rigaudelt Enstragues, is one mass of Giant's Causeway. The river Volant has excavated for itself, a deep and large bed, edged on both sides by superb basalt prisms. The escarpment, on the right side, is *d'une hauteur prodigieuse:* it is there plain, the lava has run down *a diverses reprises*, to form this *pavé a plusieurs etages.*

We have next to examine Mr. St. Fond's account of the current of lava, which has produced such mighty effects.

He admits, it is only thirty feet wide; but, he says, it must enter *fort avant dans le profondeur de terre*, to judge by the profile of the causeways it has produced; in other words, it should have been much greater. In another place, he admits its apparent diameter, to be but five or six feet; *at least, we can only see so much:* scoriæ conceal the rest, *which ought to be ten times as great.*

Is it not now plain, that a current, of such trifling dimensions, was totally insufficient, to produce the effects Mr. St. Fond ascribes to it? Must we not, therefore, when we admit his volcano, give up his current of lava, as untenable? And this exactly corresponds with the observations, made on the spot, by my ingenious and learned friend, Dr. Perceval, Professor of Chemistry, in Dublin College; who assured me, that the mountain, De la Coupe, was an extinguished volcano; but that what Mr. St. Fond called a current of lava, was merely a ravine, the effect of some torrent.

Lest, however, I should be blamed, for contradicting a gentleman, who visited the place, which I never did, I give up the point, and admit Mr. St. Fond's current of lava; which, descending the hill, enveloped some of the prisms of the pavé, of which the whole country, by his own account, is formed; and which obviously existed there, before the volcano erupted; as did Mr. Desmarest's prisms and pillars, in Auvergne.

I have dwelt upon this fact; both because it has been often quoted with much triumph, and, also, because it is the only one I ever met with, that gives a plausible support to the Volcanic Theory.

I will now proceed to examine the remaining facts, (thinly scattered through Mr. St. Fond's voluminous works,) that seem, in the least, to apply to the present question.

He found, at Montbrul, basalt prisms, at, what he calls, the bottom of an old crater; but, he adds, they develope themselves much more behind the crater, where they have formed a *pavé de Geans, des plus elevees.* (Vol. etein. page 287.)

Here it appears, by Mr. St. Fond's own account, that the lava has risen far above the crater: of course, if this be really a crater, (which I much doubt,) the pillars must have been formed antecedent to the eruption, as in all other cases.

At Chenavari, he found a colonnade of prisms, which he calls the remains of a vast crater, of which the greater part has been *ensevelie and abimee.* I believe this, without further proof, (than his supposed revolutions,) will scarcely be admitted to be a crater.

At Pont de Baume, Mr. St. Fond observed a range of articulated prisms, supporting a stratum of a different variety of basalt. This he calls a superb *coulee de lave;* but, unfortunately, he cannot determine from which of two craters it comes. (Page 300.) I fancy the reader will require some little proof, before he admits it to have issued from either.

On another occasion he is more decided; for, finding *buttes isolees* unconnected with currents of lava, he says, they were forced *hors de terre*, by the efforts of the two superior craters. (Page 269.) A combination of forces, and a conjunction of operations, which, I confess, I do not well comprehend.

Mr. St. Fond's account of Pont de Baume is very important; as it describes, accurately, a circumstance, common to many basaltic countries, to wit, strata of columnar basalt, alternating with strata of another variety of this fossil; as at Staffa, Bolsena, the Giant's Causeway, and the whole neighbouring country. We see, too, that Mr. St. Fond himself cannot reconcile this arrangement with the common mode of volcanic formation.

I will now proceed to state some of the postulates, which Mr. St. Fond finds himself under the necessity of making, in order to reconcile, to his theory, the extraordinary facts, which are perpetually occurring to him. He seems to forget, that the sole proof, adduced to support the Volcanic Theory, is, that basalt prisms were found in actual currents of lava. He now proceeds to invent, for his purpose, new and extraordinary operations, without assigning any reason, or proof, to shew, that nature ever performed any such.

Mr. St. Fond describes, and gives us a drawing of Mont Maillas, which appears to be an enormous basaltic hummock, of great elevation, formed by an horizontal stratum of columnar basalt, exhibiting a colonnade round its periphery. He admits, no crater is to be found near Mont

Maillas; and, from its height, it could not have been formed in the common way: he, therefore, assures us, that the inconceivable force of subterranean fire, *l'a fait sortir, toute formeé, de l'interieur de terre;* that is, it was forced up, *ready made.* (Page 280.)

Though Mr. St. Fond chuses to call these, explosions of his *volcaniques*, yet, he takes care to inform us, that they have nothing volcanic but the name. For Roche Rouge, a pyramidal basaltic rock, 100 feet high by 60, was forced up, (I may say, like a peg,) *par l'effort d'une explosion volcanique, de l'interieur de terre*, without being preceded, or followed, by any other volcanic phænomenon; as there are neither *scoria* nor *porous lava, nulle coulée de lave*, no crater, nor apparent volcano, in the neighbourhood. (Vol. Eteints, page 364.)

Nor does Mr. St. Fond limit his volcanic explosions to the land only: for he assures us, that Rocher St. Michel, and Rocher Corneille, though in the province of Velay, in the heart of France, were formed by submarine eruptions. (Page 341 and 344.)

What opinion the reader will form, of these mighty agents, which Mr. St. Fond introduces, to help him through his difficulties, he must determine for himself: but Mr. Dolomieu considers the discovery of them, as a superior effort of human sagacity. He can now get over his own difficulties, and account for the formation of the basaltic mount Paterno, which, he admits, could not have been formed by the common volcanic process; and of La Mothe, whose pillars are 30 feet high; and of the Cyclopian Islands, whose vertical pillars are covered with marine exuviæ. All these, he says, were formed by a sort of *vertical jet;* which, in the case of the Cyclopian Islands, carried up the bottom of the sea with it, leaving it on the tops of the pillars, where it was placed before.

I shall make no other comment, on this machinery of these gentlemen, than to observe, that it must have been managed with great dexterity; since, from their own account, it appears, that the explosion, however violent, has not deranged the perpendicularity of the pillars; at least, at Maillas, La Mothe, and the Cyclopian Islands.

Mr. St. Fond, though, in general, so well able to account for every thing, yet, on some occasions, like his friend, Mr. Desmarest, cannot suppress his doubts. He says, page 271, *on rest stupefait, et on est à chercher, d'ou a pu venir une masse, aussi etonnante, et aussi isoleé.*

And again, page 279, he was so much embarrassed, by finding a beautiful suite of prisms, imbedded in the solid rock, that, he confesses, he cannot pronounce on so delicate a subject.

Mr. Dolomieu was a friend, and a correspondent, of Mr. St. Fond; and a zealous, though, sometimes, not quite so bold, an advocate for the volcanic origin of basalt. He, too, has his doubts, as he candidly confesses to his friend; and also his postulates, though he admits he is somewhat *effrayée* at proposing them.

His

His doubts he expresses thus, in his second letter to Mr. St. Fond, from Lisbon. He says, "can a mountain be "called volcanic, which is not conic, has no crater, is "grouped with other mountains of a different species, "which form, together, but one mass? Can we say, that a "volcano has burned in a country, where we find neither "*scoria*, *pumices*, *cinders*, or *puzzolana?*"

I must confess, Mr. Dolomieu assigns good reasons to justify his doubts; which, however, he surmounts gradually; for he tells us, he thinks, the difficulty may be got over, if we concede to him, *that the agitation of the waves destroyed all other stones, except the basalts.*

At length, in his fourth letter, he pronounces himself satisfied these mountains are volcanic, *provided* his postulates be granted to him; which are, "that there have been "*four* revolutions, in this part of the globe; that the volcanos were anterior to the last *alluvion*, and posterior to "another *sejour* of the sea, which deposited the calcareous "strata, upon which these lavas are placed."

Mr. St. Fond is just as ready as his friend, to make use of *revolutions*, *submersions*, and *deluges*, to help him to get over the difficulties, which his favourite theory has to encounter. He found, at Chamarelle, in Vivarais, what he calls a current of lava, attended by many circumstances, incompatible with the state of fluidity he ascribes to it. For instance:

This lava has not only been able to penetrate the hardest calcareous rocks, *mais encore d'y circuler, tantot dans une sens, tantot dans une autre;* to cut, transversely, strata of considerable

able thickness; and thus to travel (*voyager*) more than six thousand yards, without being impeded by such barriers: and, what seems still more extraordinary, this current has not only descended the declivity, but has also ascended (*escaladée*) the skirt of the mountain, *et s'est élevé jusques sur sa crete.*

The postulates Mr. St. Fond makes, to enable him to explain this singular fact, are, that the volcano was submarine; that the current of lava, as it flowed along the bottom of the sea, impinged against the mountain of Chamarelle, at that time, as well as all the other mountains in its vicinity, submerged, *par l'effet de quelque grand revolution.* And we must presume, (as we now find them highly elevated,) that they were raised again, by some other as powerful revolution. (Min. des Volcans, chap. 13.)

I hope to be excused, for having dwelt so long upon Mr. St. Fond and Mr. Dolomieu. They are admitted to be the most eminent writors on this question; and they are both spoken of, in the highest terms, by Mr. Kirwan and Dr. Hamilton. Yet, notwithstanding this honourable testimony, from men decidedly attached to the religion they profess, I cannot help suspecting, that both Mr. St. Fond, and Mr. Dolomieu, were in the confidence of Mr. Desmarest; acquainted with his object, which we have accidentally discovered; and that they were his associates, in carrying it into effect. That they both leaned to the same conclusion he wished to draw, appears, from many passages in their writings, especially where they find basalts covered by calcareous strata.

Of Mr. St. Fond I know little, but that he was the friend and correspondent of the Duke de Rochefoucault and Mr. Desmarest, as well as of Mr. Dolomieu. Of the latter we have better information. We know that he was an *illuminatus* of the first order; a member of the Lodge of the Nine Sisters, with Rochefoucault, Brissot, Condorcet, Garat, Pethion, Danton, Bailly, and other leaders of the anti-christian and anti-monarchical conspiracy. We find him active in revolutionizing Malta, and imprisoned for similar attempts at Naples.

But, whatever may have been the ultimate object of these gentlemen and their associates; they pursued it with such activity, that they inspired their followers with the same zeal for making proselytes, which they possessed themselves; and the same contempt for truth, of which their leader, Mr. Desmarest, had set them so striking an example.

Though I do not suspect the naturalists of the British Isles, to be, in the least, privy to this conspiracy; yet, some of them seem to have adopted the French mode of supporting favourite theories; and to have modelled the *facts* they met with, so as to make them serve their purpose.

One of these gentlemen, indeed, Mr. Whitehurst, a mineralogist of some eminence, seems to have improved upon the French stile; for he *misquotes*. He tells us, " Mr. St. " Fond's treatise contains many instances, of basalts being " absolutely a part of the matter, which flowed from a " volcano, in a state of liquid fire; which evidently ap- " pears, from the same mass of lava, situated near its " crater, being wholly, or in part, columnar."

I wish Mr. Whitehurst had been so good, as to name the pages, where these instances are to be found. I certainly never met with any thing, in Mr. St. Fond's works, to warrant the strength of this passage. It seems, also, to have escaped Mr. Whitehurst, that Mr. Strange (as I have stated before) positively denies, that columnar basalt is to be found in the vicinity of a volcano: and Mr. Desmarest himself, aware of the awkwardness of this unexpected fact, feels himself under the necessity of accounting for it.

Mr. Whitehurst, too, seems as ready, as his French predecessors, to make postulates, to enable him to get over his difficulties. I have shewn, in more instances than one, the modes they have devised, to account for the total want of volcanic features, in countries, according to their theories, decidedly volcanic. Mr. Whitehurst's conjecture is new: the reader must judge of its ingenuity.

He says, " an immense tract of land, towards the north, " has been absolutely sunk, and swallowed up into the " earth, at some remote period of time, and become the " bottom of the Atlantic ocean:"

Whence, " he is almost tempted to think, that Ireland " was, originally, a part of the island Atlantis; which, ac-

" cording to Plato's Timæus, was totally swallowed up by
" a prodigious earthquake."

Here (for we must not press upon the contradictory account, of the submersion, in one place, of a *part;* in the other, of the *whole* island) we have a complete solution of the difficulty: The volcanos were all in the part called Atlantis; their lavas spread into the part now called Ireland; the former was swallowed up, but the latter remains.

Mr. Whitehurst can also misrepresent facts, with great ease and confidence. The rocks, at Portrush strand, he says, "*consist altogether of masses of black lava; so extremely*
" *replete with bladder holes, that it perfectly resembles the sco-*
" *ria of iron; and, therefore, leaves not the least doubt of its*
" *being a volcanic production.*" (Page 249.)

These rocks, at Portrush strand, are opposite to my door. I have often examined them, and affirm, they are composed of strata of solid table basalt, sometimes thickly studded with zeolite: their fracture, like that of other basalt; no resemblance whatsoever to *scoria;* nor do they contain a single bladder hole. I can also assure the reader, that Mr. Whitehurst did not alight from his horse, to examine these rocks, which, by his own account, so effectually establish his favourite theory.

Bladder holes, or internal cavities, *(I pori nell interno,)* are admitted, by most of the foreign naturalists, to be essential to lava. Mr. Kirwan assigns the reason; as such cavities are the necessary effect of the fusion of earthy substances. Hence it comes, that the advocates for the igneous origin of basalt, are so ready to give this fossil pores and bladder holes. For my own part, I never met with, in any of our basalts, internal cavities; except such as once contained water, or those from which zeolites had fallen out; and even these very rarely.

I shall now proceed to two other facts, which seem to countenance the volcanic origin of basalt.

The first is stated by Dr. Troil, who observed in Iceland, as he tells us, "basalt pillars, peeping out from "among the lava, and still oftener from among the tufa."

Iceland is, unquestionably, both a basaltic, and a volcanic country. The question to decide here, is: were these pillars formed out of the materials, among which they appeared? or, was the coincidence accidental? Now, as I apprehend, no one will maintain, that the *tufa* was formed into basalt pillars; they must necessarily have been enveloped by the *tufa*, that fell among them. The reader is, then, to determine, upon these scanty data, (for Dr. Troil does not give much assistance,) if it be not probable, that the pre-existing basalt was enveloped by the *lava*, as well as by the *tufa;* and if so, the original question rests as it stood.

The only remaining fact, that has come in my way, that seems to apply to this question, is related by Abbé Spalanzani. He found, at the bottom of the crater of Volcano, in the Lipari Islands, "*pentagonal basalt prisms.* On "looking up the sides of the crater, he perceived, they "came from a great bed of lava, almost vertical; divided,

"in its length, into articulate prisms: the lava, in which
" they were, descended to the ground, and was incon-
" siderable."

I must observe, that Spalanzani, as well as other advocates for the volcanic origin of basalt, generally uses the terms, *lava*, and *basalt*, as synonimous; and that Spalanzani talks of the volcanos of Ireland, and of Antrim, with as much ease as Mr. St. Fond, or any of them.

The very critical situation, in which these prisms were found, to wit, the bottom of an unquestioned crater, will, I hope, procure my excuse, for entering into a minute investigation of the circumstances attending them, as related by the Abbé himself; and I will argue from his own facts alone.

Had this lava been melted in the crater, accompanied by an effervescence, and then a *retraite*, to which Spalanzani ascribes the formation of the pillars; it must have obeyed the laws of other fluids, and assumed an horizontal level: but never could have formed a narrow, vertical stripe, *the lava of which scarcely reached to the bottom of the crater.*

The material, too, of which these prisms were composed, is very important. Their base, Spalanzani says, was *petrosilex:* that he was well acquainted with such lavas; in all of which, the *petrosilex* bore strong marks of fire. On the contrary, the *petrosilex*, in these prisms, had not suffered the slightest alteration from the fire, *although it is very certain they had been fused.*

Now, this *certainty*, that these prisms had been fused, arises solely from the admission of the general position, that all articulated prisms were once fluid lava. Withdraw that admission, and then the total want of any mark of fire, on this *petrosilex*, is little short of demonstration, that it never had been in fusion.

For this we have good authority. Mr. Kirwan (Trans. R. I. A. Vol. V. page 7th) tells us, " petrosilex and other " fusible stones have a quite different aspect, when they " pass through a state of fusion, from that which they " present in their natural state."

These two circumstances, extracted from Spalanzani's own account of this horrible place (as he calls it), induce me to believe, that these prisms also (though found in so critical a situation, as the crater of an existing volcano), like the others, I have already mentioned, were antecedent to the first eruption.

Thus, it appears, that every fact, stated by the advocates for the volcanic origin of basalt, when minutely examined, leads to the same conclusion; that the basalts, supposed to be lava, existed, previous to the eruptions, or formation of the volcanos.

I would be glad to know, what ideas the advocates for this theory annex, to the terms they are perpetually using; *granitic lava*, *porphyritic lava*, or, as Spalanzani says, *petrosilex lava:* unless it be, that granite, porphyry, and petrosilex, were the mother stones, from the fusion of which, these lavas were formed; and, that the more common lava, generally called, by these gentlemen, *basaltique lave*, is merely fused basalt, as was first suggested, I believe, by Mr. Werner,

Hence, we can easily account for the resemblance between basalt and lava: and we are no longer surprised, that chemists have proved them to consist of exactly the same materials, and in the same proportions.

Whether Mr. St. Fond was aware, or not, that lava was merely fused basalt, I will not presume to inquire; as he is perpetually asserting the contrary. Yet, it appears rather extraordinary, that the truth of this proposition should have escaped him; as Mr. Werner could not have demonstrated it better, than Mr. St. Fond himself has done, in the fourteenth chapter of his "*Mineralogie des* "*Volcans*."

The title he gives this chapter is, "*Basaltes et Laves* "*compactes, passant à l'etat des Laves cellulaires:*" and he commences it, by pronouncing, "*les laves poreuses doivent* "*leur origine à lave compacte, ou basalte recuite.*" He then tells us, "*art peut imiter en petit, ce que la nature execute* "*en grand:*" which he explains, by shewing, that, while nature fuses basalt, and turns it into lava, in the craters of volcanos; art can do the same thing *en petit*, and change the basalt, of which lime-kilns are built, into porous lava.

This he confirms by a specimen, which, though the work of art, "*n'en est moins propre a repandre du jour sur* "*la theorie des laves poreuses.*"

His comment, upon this specimen, I shall also give, in his own words.

" *L'on voit dans cette echantillon, des parties, où la lave*
" *est encore basaltique; tandis que le reste est entierement chan-*
" *gée par l'action du feu, en lave poreuse.—Le passage du ba-*
" *salte, et de la lave compacte, a l'etat de lave poreuse, est*
" *ici fait par gradation.*"

I suspect this specimen of Mr. St. Fond, to be similar to the one, found by Mr. Whitehurst, at the Giant's Causeway, among the fragments of lava, as he calls our rubble, " a piece of iron ore, vitrified on one side: which " is some testimony, that the substances, supposed to be " lava, have, also, been in a state of fusion."

This must have been a paltry volcano of Mr. Whitehurst's, that could vitrify but one side of this fragment.

Dr. Troil, too, found, on the shore, in one of the western islands of Scotland, a fragment, as he says, " *exte-* " *riorly, full of holes, and, in a manner, burnt.*" This he sent, in great triumph, to Sir Torbern Bergman, as a proof, that volcanos had once burnt in these islands.

Had either of these gentlemen looked around them, they would soon have found the craters, in which their respective specimens had been acted upon, to wit, the ruins of *kelp-kilns*, with which the shores in both countries abound. Upon the walls of these, the fire produces the same effect on the basalt, of which they are built, as the same agent does, at Mr. St. Fond's *lime-kilns*.

An arch friend, amused at the discoveries these sagacious gentlemen were making, in natural history, gave me a neat view of the profile of the cliff, beyond the Giant's Causeway; with a *kelp-kiln*, burning on the Causeway itself, and people busily employed. Underneath, he gave the following explanation:

The natives, at the Giant's Causeway; making lava for Dr. Troil and Mr. Whitehurst.

A new theory has sprung out of the volcanic one; as maintained by Mr. Desmarest, and the other gentlemen, whose works I have just now observed upon. Of this theory, I cannot avoid taking notice; since it is warmly defended, in his Letters on Antrim, by Dr. Hamilton, who spent much time in our basaltic country; and also (as I hear) supported, from a chair in our university, by a gentleman, whose able discharge of his duty, as professor, has done him much honour.

This theory supposes basalt pillars to be formed, by crystallization, in the interior of the craters of volcanos; and not, as hitherto supposed, in the currents of lava. And Dr. Hamilton (Lett. VII. Part 2.) labours much to prove, that currents of liquid lava are totally unfit for the formation of crystals; while "*the interior of the mountain, at its* "*lowest base, beneath the surface of the earth,*" is admirably adapted for the purpose.

This new opinion seems to me to be founded, on a total dereliction of Mr. Desmarest's premises, and a pertinacious adherence to his conclusion. Had Dr. Hamilton forgotten, that the only proof ever given, of the igneous origin of basalt prisms, was, that they were found in actual currents of lava? Admit the validity of his arguments, that they could not have been so formed; and the question, whether basalt was once fluid lava? is to be taken up, *de novo*, not having as yet advanced a single step: for the aptitude of the new laboratories, which the advocates for this theory have discovered, proves nothing; unless they can also shew, that they have been actually employed, in the fabrication of such pillars and prisms.

Dr. Hamilton seems well aware of the necessity of this species of proof; and promises it to his readers, provided they will have patience: but, he says, "we must wait, "until those volcanic mountains, which, at present, burn "with so much fury, shall have completed the period of "their existence; until the immense vaults, which now lie "within their bowels, no longer able to support the incumbent weight, shall fall in, and disclose, to view, the won"ders of the subterranean world: and then we may expect "to behold, all the varieties of crystallization; such as must "needs take place, in these vast laboratories of nature: "then may we hope to see banks and causeways of basalts."

I am sorry Dr. Hamilton has put off, to such a remote period, a proof, which would have effectually decided the question in his own favour. Many naturalists, who now take an interest in it, may happen to complete the period of their own existence, before they are favoured with such perfect demonstration; and, particularly, Mr. Hoepfner, of Viel, who was so anxious for the solution of this question, that he promised a premium, of twenty-five rixdollars, to whoever would satisfactorily resolve it. What a pity, should this gentleman be unfortunately carried off, before he had an opportunity of witnessing Dr. Hamilton's demonstration, and contemplating the magnificent spectacle he promises!

I do not insinuate, that he relies solely on the evidence to be produced at remote periods: for he tells us; " of such " phenomena as these, we have even some anticipation, in " the present living volcanos."

Thus, he says, " the mountain de la Coupe rests on a " columnar base; whose pillars have been laid bare, by " the impetuous torrents of the river Ardesche; whose " banks are formed of columnar basalts;" which, by this new theory, were formed in the bottom of the crater.

Here we have a happy instance of the dexterity, with which modern theorists select, from the same fact, such circumstances, as seem favourable to their opinions: never troubling their readers with those that make against them. For, though Dr. Hamilton refers us to Mr. St. Fond, for his account of this mountain, he takes no notice of the current of lava, which Mr. St. Fond traced from its crater to the plain; by which all the pavés about it were formed, as he says: and he both states, that basalt prisms were found in this current; and, also, in the view he gives of this mountain, and its current of lava, he exhibits the pillars, in the very current.

Of this important fact, which Mr. Whitehurst quotes with triumph, Dr. Hamilton takes not the least notice; for, it would have been very awkward, when demonstrating the impossibility, of basalt pillars being formed in currents of lava, to have mentioned an instance, where Mr. St. Fond, whom he admires so much, had found them in an actual current.

As to the argument, drawn from Ætna and Mont de la Coupe, resting on columnar bases, I must observe, that, from the accounts, given by Mr. St. Fond and Mr. Dolomieu, of these mountains, it appears, that the whole country, surrounding the latter, was formed of columnar basalt; and, as to Ætna, Dr. Hamilton himself quotes Mr. Dolomieu, to shew, that, in its whole contour, basalt pillars were found, and that they formed a circular cincture about it, from twelve to eighteen hundred feet high.

Now, if we adopt Dr. Hamilton's theory, we must admit, that the whole country, round these volcanos, was once included in their craters; a concession, which the reader will not readily make.

Besides, Dr. Hamilton ascribes the formation of these prisms to *crystallization;* a principle totally different from that adopted by Mr. Desmarest and Mr St. Fond; who make the operations, by which they were formed, analogous to *desiccation;* and, like it, they seem to require exposure to the external air: and Mr. Kirwan has clearly proved, that basalt prisms do not acquire their regular forms by crystallization; as the differences between them, and all known crystals, are numerous and essential.

I should now (as I do on similar occasions) proceed to shew, that, notwithstanding Dr. Hamilton's plausible arguments, *a priori,* the abrupt promontories of Antrim (whose *uncommon beauties,* as he tells us, page 147, second part, resemble what will be exhibited at the grand opening of his *vast laboratories of nature)* were not formed according to the principles of this theory.

But, as Dr. Hamilton has not given us any account whatsoever, of the volcanos, in whose craters *the mountain of* Dunmull, *the mountain of* Croaghmore, Fair-Head, *towering magnificently,* and *the lofty cliffs of* Magilligan, were formed; (and, to their summits, they are all composed of columnar basalt, by his own account;) I have no materials to proceed upon; and must, therefore, limit myself to one general argument, applicable to all other volcanic countries, as well as to our own.

The basalts of Auvergne are arranged in *plusieurs etages,* according to Mr. Desmarest. Mr. St. Fond applies the same phrase to Vivarais, and says, they were formed *a diverses reprises.* The account of Sicily is similar; and, with us, they are invariably disposed, in successive, distinct strata, which never could have been the result of fusion, in the crater of a volcano; as such an operation necessarily would have reduced them to *one* mass, *one* stratum.

PART III.

ARGUMENTS

AGAINST THE VOLCANIC ORIGIN OF BASALT,

DERIVED FROM ITS

ARRANGEMENT IN THE COUNTY OF ANTRIM,

AND FROM OTHER FACTS OBSERVED IN THAT COUNTRY.

CELEBRARE DOMESTICA FACTA. HORACE.

I HAVE, in the preceding parts of this Memoir, discussed most of the arguments, that have been adduced, by different writers, to support the volcanic origin of basalt: and I have examined the facts, stated by them, to try how far they apply to this question.

I now return to my own country, which seems more copiously furnished with curious basaltic facts, than any of those upon which foreign writers have dwelt so much.

The question (to us at least) is important; for it is the origin of the ground we live upon, that we are inquiring into: every particle of the surface of an extensive basaltic area, having merely a thin coat of most fertile earth, slightly covering basalt strata, accumulated upon each other to a great height; and, most frequently, as it were, bursting through this surface, and displaying, in perpendicular façades, the arrangement of the materials that support us.

Whether these materials, so arranged, be formed by the hand of nature, in her original construction of the world; and thus our basaltic strata (in the language of naturalists) be entitled to the appellation of *primary:* or, whether this construction of our country is to be considered as produced by mighty agents, covering our quondam surface, with new, and *secondary* strata, poured forth from the bowels of the earth, is surely an interesting question, in the natural history of our country. And, as every writer, who has taken up the question, of the volcanic origin of basalt, and maintained the affirmative, has recurred to the county of Antrim for proofs; I hope that I, too, will be allowed to extract, from the same source, such proofs, as appear to me to support the negative.

In discussing this question, I shall abstain from all arguments *a priori,* and limit myself to *facts* alone: of which I hope to lay before the reader, several, that have escaped the notice of my predecessors; feeling, that I ought to make him some amends for having detained him so long, in a barren discussion of opinions, and an uninteresting detection of misrepresentations.

Before I proceed to compare the circumstances, in which our basaltic area resembles, or differs from, volcanic countries; I must answer a charge, that has been brought against me. I have been told, that it is presumption in me, who never saw a volcano, to take up a question, the solution of which must depend upon an intimate knowledge, both of basaltic, and volcanic countries.

I first plead example; as not one of my predecessors, who have written upon this topic, has (so far as I can find) examined both volcanic countries, and our basaltic one.

I have also authority for saying, that an examination of existing volcanos is not very instructive. Mr. Kirwan tells us, Collini twice ascended Vesuvius, and witnessed its eruptions; but complains, he got no knowledge by it. Mr. Ferber's testimony is exactly similar. And, indeed, it is plain, that, in an eruption, the lighter materials first projected upwards; then, falling down, and accumulating upon the weightier, that had flowed in lava, must make it very difficult to trace arrangement: and this is the surest guide, in all questions relative to cosmogony.

Mr. Strange's observations on this topic are amusing: he lets out the secret, without knowing it, or availing himself of it. He says, "The phænomena of recent volcanos "are very little calculated to give us instruction. A few "days tour in Auvergne, Velay, or the Venetian State, "are worth a seven years apprenticeship at the foot of "Vesuvius or Ætna."

Mr. Strange was not aware, that Auvergne, Velay, and the parts of the Venetian state he alludes to, were originally basaltic countries, in which, afterwards, volcanos erupted. Here he found a rich variety of materials: for, besides the common volcanic substances, he found all the varieties of basalt, with the matters that usually accompany them, *ochres*, *zeolites*, *chalcedonies*, and *calcareous spar;*

while at Ætna and Vesuvius, he met with burnt matters alone.

The points of view, in which I shall compare volcanic countries, as described by the most accredited writers, with our basaltic district, so often referred to, by the same authors, are:

First. The prominent features, and general resemblance.

Secondly. The different arrangement of the materials, in volcanic, and our basaltic countries.

Thirdly. Frequent change in the arrangement of the materials, in our basaltic country.

Fourthly. Striking and radical differences between our basalt strata, and all known currents of lava.

Fifthly. Substances found imbedded in our basalt, and never in lava.

Sixthly. Different effects produced upon foreign substances (particularly calcareous), when coming in contact with basalt, and with lava.

Seventhly. Divisibility of the mass into regular forms, essential to basalt, but never noticed in lava.

First. The general and leading features of volcanic countries are admitted to be, *isolated mountains*, generally conic, *truncated cones*, *vast craters*, with *currents of lava* issuing from them, which may be traced many miles. But, as all writers upon this topic candidly admit, that we have nothing similar in this country; I will not press the argument; nor enquire, whether their modes, of accounting for the want of these features, be satisfactory or not.

Secondly. If basalt be lava, and (as this theory supposes) once flowed from a volcano, we should expect to find it arranged in the same manner, with the currents of lava, which are contiguous to most known volcanos. But here the difference is most striking: for, while all writers, that describe volcanic countries, represent the ejected matters as confusedly arranged, and, altogether, a heap of disorder; with us, we observe, in the disposal of our basalt, the most consummate regularity; every separate stratum preserving steadily its own place, and never breaking into that of another.

Besides, most writers admit, that currents of lava are never parallel to one another: while our basalt strata, accumulated upon each other, preserve the most steady parallelism.

When we compare our accumulations of basalt strata, with accumulations of currents of lava, which have been heaped upon one another, by successive eruptions, we observe a most important difference. Currents of lava have always a layer of vegetable earth between them: this is admitted by all parties. For, while those, who wish to impeach the chronology of Moses, make a prodigious interval between the eruptions, necessary for the formation of this layer of earth; Moses's advocates prove, from facts, that it is often formed in a much shorter time.

Interposing layers between currents of lava, being thus established, we are to look, if any thing similar can be observed between basalt strata: but no such thing is to be found. Our basalt strata, whether of the same, or of different varieties, pass into each other *per saltum*, without interrupting the solidity of the mass, or without exhibiting a particle of extraneous matter between them.*

Thirdly. I observed, in a former Memoir, that, on our basaltic coast, nature changes her materials, and the stile of her arrangement, every two or three miles; a fact, which opposes unsurmountable difficulties to the position, that the basalt strata, forming this coast, are of volcanic origin. I will select two or three of these numerous little systems, and state the order in which the strata are arranged in each of them, in a vertical direction; to give the advocates for their volcanic origin an opportunity of exerting their ingenuity, by shewing how they manage their volcanos, to make them produce such diversified effects.

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* I am aware, that the ochreous layers, or strata, lying between our greater basalt strata, may be stated, as contradicting this position.

The nature of these ochres (common to all basaltic countries) has given rise to much controversy; which were I to enter into now, I would be led too far from the present question. But, as this fossil makes a most conspicuous figure in many parts of Antrim, I think it well entitled to a place in the *statistical survey* of that county; the basaltic part of which I have undertaken, to oblige my friend, Mr. Dubourdieu.

On the present occasion I shall only say, that I accede to the conclusion, which Mr. St. Fond adopted, after long doubt, and much puzzling; to wit, "*That these ochres were pure basalt, altered by some chemical operation of* "*nature, with which we are unacquainted.*"

From Dunluce to Seaport, the façade (here the base of the arrangement) is composed of strata of tabular basalt; upon which are accumulated, up to the summit of Dunmull, columnar strata, mixed with others, of the variety called *irregular prismatic.*

East from Carrickarede, the base of the façade is white limestone: upon which, as long as it continues perpendicular, we find ochreous and columnar strata alternating; while the hill of Knocksoghy, above, is an uniform alternation of columnar and irregular prismatic.

The strata, forming the promontory of Bengore, are more irregularly mixed: six of tabular basalt, five columnar, of four different varieties, three ochreous, and two irregular prismatic, sixteen in all; of which, after the tabular, that forms the base, no two of the same kind are contiguous to each other.

The volcanist will see, that he must find a distinct volcano for every separate little system, surrounding our area; and that he must make the same crater emit different varieties of lava, and frequently by alternation.

Fourthly. An examination of our basalt strata, taken separately, and so compared with distinct currents of lava, will, I apprehend, turn out as little favourable to their volcanic origin, as the comparison of their masses appear to do.

Whoever has read Mr. Desmarest's Memoir, or even my quotations from it, must admit, that, if his theory be well founded, all our basalt strata must have once been currents of liquid lava; and, of course, should resemble those known to have issued from existing volcanos. But, I apprehend, instead of similarity, the most decided differences will be found between them.

Currents of lava, we are told, are always narrower and deeper, in the vicinity of the crater; broader and shallower, as farther removed from it: but our basalt strata are of uniform thickness in their whole extent.

There is another point of view, in which the difference, between basalt strata, and currents of lava, is still more decided. Sir William Hamilton, Ferber, Spalanzani, and even Mr. Desmarest himself, inform us, that, in all currents of lava, the materials composing them are invariably arranged, in a regular gradation, according to their specific gravities: thus, at the lowest part of the current, compact lava, then cellular lava, then scoria, next cinders, and lastly, volcanic ashes. But, in our basalt strata, nothing similar is observed: the material is uniform; both density and specific gravity the same, through the whole thickness of our deepest strata.

Fifthly. That basalt never was in fusion, appears plainly, from the substances found in it, and never in lava; and which, from their nature, could not have sustained the heat of a volcano.

Of these, zeolite, chalcedony, and calcareous spar, seem to abound in the basalt of all countries, but never have been noticed in unquestioned lava. The first fuses, and the third calcines, in a very moderate heat; and, though chalcedony be more refractory, yet exposed to a strong heat, it loses its beauty, and the delicacy it exhibits in its natural state. These substances are most copiously dispersed, also, through our basalts; but, as this topic has already been often urged, I will pass on to substances, peculiar to my own country.

A variety of basalt, found in abundance at Portrush, and the Skerrie Islands, is full of pectinites of belemnites, and, above all, of cornua ammonis: these are dispersed through the whole mass, equally abundant in the interior, and on the surface. This basalt vitrifies, and the marine substances, it contains, calcine, in the fire of a common salt-pan; of course, never could have sustained a volcanic heat.

Another fact occurs, which seems decisive against the volcanic origin of basalt. Some varieties of this fossil, contiguous to Portrush and the Giant's Causeway, upon being broken by a sledge, discover, in their interior, cavities, some filled with fresh water; others bearing evident marks of having once contained it. Of these basalts, some were of a different variety from that of the Giant's Causeway, but of similar grain and hardness; others were precisely of the same variety, *columnar*, *prismatic*, *articulated*, and exactly the same in grain. At the Causeway itself.

itself, I never found any; but, in some basalts very near it, on the west side, I have met with it: these had fallen from an upper stratum.

A most respectable correspondent, to whom I communicated this fact, as new in natural history, tells me, he suspects, the water passed in by percolation. Determined to pay all attention to any thing, suggested from such high authority, I took my friend, Mr. Joy, to the spot, where I used to find the water in the greatest abundance (Ballylagan). We broke several stones, and, where we found water, observed, that, at first, it wet the whole fracture evenly; but, as it evaporated gradually, the wet was confined to cracks, diverging from the little cavity that had contained the water. These, therefore, we at first supposed, must have been the passages, through which the water had made its way: but, on attentively examining the cracks, we perceived, that, as they radiated from the cavity, they diminished in breadth, and finally terminated in the solid stone; of course, that the water had not come in by them.

Another fact seems conclusive against percolation. I never found, in our basalt, any cavities, but those which contained water, or which bore evident marks of having been once filled with it. We have, therefore, this alternative:

Either the water first made its way through the compact tissue of the basalt, then collected, and dilated itself with such force, as to form rounded cavities, often larger than a pistol bullet, which, on many occasions, it afterwards forsook:

Or, we must admit the water to have been coeval with the basalt; to which, of course, we cannot ascribe an igneous origin.

Sixthly. As we know the high state of ignition, in which lava issues from a volcano, it is reasonable to expect, that, when, in its course, it meets with extraneous substances, it should produce upon them such alterations, as are the usual effect of intense heat, applied to these same substances. Basalt, likewise, is often found in contact with similar matters. Hence, by a minute examination of these contacts, we have an obvious mode of ascertaining, whether the basalt also had encountered them, in the same state of ignition, we know the lava did.

As my country, to a great extent around me, is composed of nothing but basalt and limestone, I have no other substance but limestone, upon which I can make observations. This, however, I apprehend, will be found abundantly sufficient, to decide the question.

About one hundred yards from the beautiful cavern, called Long Gilbert, near the eastern extremity of the calcareous façade, a mile from Portrush, we find, half way up the precipice, a vast basaltic rock, inserted in the middle of the limestone mass; and, at the contact, so united to the limestone, as to form, with it, but one solid mass.

The peninsula of Kenbaan, near Ballycastle, is the spot, where basalt and limestone come in contact in every possible way. Pieces of limestone of all sizes, imbedded in the basaltic mass, and similar fragments of basalt, dispersed in like manner through the limestone; and, in the precipice above, strata of basalt, and limestone alternating. Here the opportunities, of examining the contact of basalt and limestone, are numberless; and, on every occasion, I found them united solidly; the line of demarcation correct, as if drawn by a pencil; not the least trace of calcination, such as might be expected from the calcareous matter, coming in contact with so glowing a mass, as this theory supposes our basalt to have been.*

This unexpected circumstance has somewhat embarrassed the volcanists; who, to account for it, have been driven to various exertions of their ingenuity: but not one of them seems ever to have inquired what was the result, when calcareous matters came in contact with actual lava, as it flowed. Here an obvious mode presents itself, of deciding the question, whether basalt and lava have a common origin. For, if their contacts with calcareous matter, produce the same effects upon it, we have a strong presumption in favour of the affirmative.
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* The result of my observations, on the contacts of basalt and limestone, perfectly correspond with those of Mr. St. Fond, in Vivarais. (Min. des Volcans, chap. 13.) Dr. Hamilton, I admit, saw things in a different point of view; but, as he does not refer us to the places, where he examined these contacts, I cannot bring the point to issue in my country.

On the contrary, should the effects turn out to be totally different, we have a conclusive argument in support of the negative.

Whether this mode, of bringing the question to issue, did not occur to the gentlemen, who support the volcanic origin of basalt; or whether they did not like to commit a favourite theory to so rude a test, I will not presume to conjecture. Direct evidence, with a view to the question, I admit, I have none; yet, by an attentive examination of different writers on volcanic subjects, I find pretty good light is thrown upon this topic. The evidence I will adduce, is, I confess, indirect, and the mention of the subject incidental: yet I do not, therefore, give it less weight; for, since I engaged in polemic natural history, I have discovered, that a reliance on positive assertion, is not the surest mode of obtaining truth.

The first evidence I shall produce, to the effect of actual glowing lava, upon calcareous substances, is that of Lord Winchelsea: whose letter to King Charles II. (quoted by Sir William Hamilton), giving an account of the great eruption of Ætna in 1669, says; " Where the streams of " lava meet with rocks and stones of the same matter, " (as many are), they melt, and go away with the fire. " Where they meet with other compositions" (calcareous, no doubt), " they turn them to lime or ashes."

Mr. Ferber's testimony on the subject is decisive. He gives us, in his eleventh letter, a catalogue of ejections from Vesuvius: of which No. 6 is, by his account,

" white limestone or marble, in loose pieces; some burnt " and calcined." He observes, " they are found, likewise, " in the ashes and lava, and then constantly calcined and " farinaceous." Again, Letter 14, he says, " at Monte " Albano, the lava, as well as the piperino, contain cal- " cined fragments of limestone."

Tozzetti di Targioni, in his elaborate account of the mineralogical productions of his own country, confirms Ferber's testimony, as to the uniform calcination of calcareous substances.*

Since, then, glowing lava uniformly calcines the calcareous substances it comes in contact with, and basalt produces no effect whatsoever upon them; are we not to conclude, that it did not encounter them in a state of fusion? which is the point in question.

Seventhly. Upon the last difference I shall mention, between basalt and lava, I must dwell a little longer: both because it seems radical and essential; and also, because it lays open some new and curious facts, relative to basalt, which have hitherto escaped notice.

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* Tozzetti is full on the subject. He says, (page 448, Vol. IX.) " Se " materiali sieno di natura *vitrescenti*, formeranno lave *vetrine*, se *calcarei* o " *apiri*, le formeranno *polverose*."

Page 250. " In essi (lave vesuviane) si vedono misti materie vetrificate, " con materie calcinate, e con altri quasi non punto tocche dal fuoco."

Page 252. " Il fuoco volcanico, nelle vescere della montagna di San " Fiora, abbia offeso—fuse le massolette di metalli, e calcinate o vetrificate, secondo la loro attitudine altre sostanze."

I allude to that property, which all basalt strata, that I ever examined, have, of dividing or separating into regular forms, generally with plain sides. For, that this is a principle inherent in the mass, and coeval with its original formation, is obvious, from the striking difference between the plain brown side of the figure, and the irregular, granular fracture, generally blue or grey: the former an arrangement of nature, the uniform effect of a cause, with which we are unacquainted; the latter the irregular effect of a violent stroke or impulse.

If the theory we are discussing be well founded, all our basalt strata were once currents of lava, flowing from volcanos. For this we have the authority, or, rather, the assertion, of the founder, and the most accredited supporters of the opinion. In substances, therefore, by their accounts, exactly the same, and of the same origin, (for they use basalt and lava as synonymous terms,) we have a right to expect similar properties; and to look for in lava, an internal arrangement of the mass into regular forms, conformable to what we meet with in all basalts. But nothing similar has been observed in lava, and the description of the Volvic lava is irreconcileable to this property; for we are told it breaks in all directions, *casse en tout sens:* and Mr. Desmarest himself mentions this, as a mark of distinction, between it and the neighbouring basalt.

In distinguishing the varieties of lava, we have a clew to guide us. We know the process by which it was formed:

formed; and often, upon inspection, we can discover the original material, the mother stone, by whose fusion it was made. The operation itself, too, enables us to make new distinctions, from the different intensity of heat, and different gradations in cooling.

On the contrary, we get little information from inspecting the fracture of basalt. We can tell, that in some, the constituent materials are more completely blended, than in others: which seems the same thing as to say, there is much difference in grain; a great interval between the coarsest and the finest. But all this is by insensible shades; no such thing as drawing lines, by which we can mark the varieties of this fossil. Even where other differences are most essential, between the varieties of basalt, inspection cannot be relied upon. For instance, the siliceous basalt, full of marine exuviæ, passes, by gradation, from a grain, as fine as jasper, until it becomes indistinguishable from the Giant's Causeway stone, and even coarser.

If we look to nature for assistance, in classing the varieties of basalt, we will be no longer at a loss: we will find, she has impressed an indelible character on each variety of this fossil; a specific figure, into which every stratum is divisible, in its whole extent: being formed, as it were, by an agglutination of similar figures;* in the same stratum, all of nearly the same degree of perfection; but, when we compare different strata, of the same variety, the perfection or neatness of the work varies, until it passes into an amorphous mass.

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* I do not use the word *similar*, in a strict mathematical sense; meaning no more than a strong, general likeness, so decided, that the figures of one variety cannot be mistaken for those of another.

Nature seems to have provided, as carefully, for the preservation of the distinctive characters, of the different varieties of basalt, as she has done, to prevent confusion in the several tribes of the animal and vegetable kingdoms. We see our basalts often, by gradation, losing their own forms, but never assuming that of another variety; and, in the last stage of evanescent form, we can trace an effort to preserve their own appropriate figure. This is very observable in our columnar basalt, and in the long horizontal prisms of our whyn dykes.

I can also trace something like a generic difference, between the varieties of our basalt: for some of them have but one principle of construction, to wit, the external, visible forms; into which, upon the slightest inspection, they appear to be divided: no internal construction; the fracture irregular, and generally conchoidal. The basalts of this class are, the columnar, the irregular prismatic, and the tabular. I have not been able to discover subordinate forms, or an internal construction, in any of these basalts.

Other varieties, on the contrary, are regularly arranged internally; the large prism breaking into smaller, sometimes to a great degree of minuteness, as in the Portrush siliceous basalt. The coarse Portrush basalt, whose prisms are mostly quadrangular, and the unarticulated pillars of Ballylagan, have, likewise, the same property, in an inferior degree; while the basalts of our whyn dykes have often their subordinate prisms finished with great neatness.*

But the forms, into which our basaltic masses divide, are, by no means, limited to prismatic alone. The pyramid is a common figure in our whyn dykes; and the most perfect joints, of the Giant's Causeway pillars, partake both of the prism and of the pyramid, and have also a mixture of curve, and plain surfaces: the latter in number equal to the denominator of the figure; while the former amounts to double that number, plus two. Thus, a pentagon joint, taken from one of our most perfect pillars, has five plain, and twelve curve surfaces; but curve surfaces are irreconcileable, either to *crystallization* or *desiccation*.†

We have another variety of basalt, whose surfaces external,

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* This subordinate construction is well illustrated, in a drawing of three prismatic stones, taken from a great whyn dyke (now used as a quarry), nearly two miles west from Belfast.

The constituent figure here, is a triangular prism, whose angles, at the base, seem double the angle at the vertex.

My ingenious friend, Dr. M'Donnel, to whom I had mentioned the curious construction of our whyn dykes, was so struck, when he saw the prismatic stones, of which this dyke is formed, extracted from the quarry, that he employed a painter, to make a drawing of some of them; and he was so good as to give me a copy.

† The acute-angled, triangular *pyramids*, which ascend from each angle of the joint, and often reach up to the middle of the incumbent one, have their

ternal, and, if I be allowed the expression, internal, are all curves: its form is round, and it is composed of concentric spheres, like the pellicles of an onion.

This variety Mr. St. Fond himself admits not to be of volcanic origin. He says, (Min. des Volc. page 46,) *it must have taken this configuration naturally*. Its mode of arrangement, in the places where it is found, seems still more extraordinary. It is generally imbedded in an indurated basaltic paste; in Mr. St. Fond's language, *incorporeé et encastreé dans des massifs de basalte informe*. In this state, it is sometimes built in the form of a wall; of which the globular

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their insides sloped away, in an hyperbolic curve; while the grooves, in the lower part of each joint, adapted to receive these, with similar curvature, added to the former, make twice as many curve surfaces, as the figure has angles. The concave and convex bases add two more; but, by Sir Torbern Bergman's definition, crystals are bounded by *plain surfaces*.

These facts cannot be exhibited in distinct joints; for, the cohesion is so strong, that the ascending pyramids invariably break off, as the joints are separated from the pillar. It is the projecting fracture that remains, which gives the joint the appearance of a *mural crown*, as was observed by the early writers on the subject.

The destruction of these ascending pyramids, makes the separate joint totally different from what it was, when existing in the perfect pillar.

To illustrate all this, I give a drawing of two pillars: one, as it appears, when long exposed to the air, which acts principally upon the joints; while the dilatation and contraction, from heat and cold, loosens the pyramids, and separates them from the pillar

The second pillar exactly represents the state in which they appear: where the mass is lately quarried into, and the air has not had time to operate.

I add some joints in their natural state. This nicety of construction abates, as the pillars graduate through imperfection, to an amorphous mass; yet occasional traces of it are long observable.

bular basalt is the stones, and the unformed the cement.

I have great reason to believe, that the varieties of basalt, in other countries, are exactly the same as in our own; and that nature has taken the same pains to keep them distinct every where.

The columnar basalt, of all countries, corresponds precisely with that of the Giant's Causeway, and our other groups, as appears from the sameness of their curious articulations.

Our irregular prismatic exactly answers the descriptio of the basalt, incumbent on the columnar at Bolsena, as given by Ferber. It is obviously similar to those at La Trezza and Pont du Baume; and Mr. Mills's view of the isolated basaltic rock, at Ardlun (Phil. Trans. 1790), accurately represents this variety, in many façades, near the Giant's Causeway.

Sir Joseph Banks's account of the stratum, incumbent on the columnar, at Staffa, might serve for our irregular prismatic, in most places; and, the moment I shewed my friend, Mr. Joy, our neat pillars at Craigahuller, he perceived the striking likeness between the stratum, incumbent on them, and that covering the grand colonnade at Staffa.

The slight accounts we have, of the Scotch whyn dykes, shew, that they are formed, like our own, of horizontal prisms.

And our globular basalts, with concentric spheres, so curiously imbedded, as we find them, at Port Cooan, near the Giant's Causeway, and lining some whyn dykes, at

Belfast Lough, are precisely the same with those, taken notice of by Mr. St. Fond, at Ardenne, at Cheidevant, at Montbrul; and also by Mr. Strange, in the Venetian state.

Until the advocates, for the volcanic origin of basalt, can discover, in lavas, something corresponding to these curious circumstances, attending our basalts; can they persist in pronouncing them to be identically the same? The one (if I may be allowed to use the expression), a *factitious* substance, of known, and posterior formation; the other, bearing evident marks of the hand of nature, both in its general arrangement in mighty strata, and also in its numerous varieties. For we know, that nature delights in diversifying her operations; and in executing, what seems to us, the same work, in many different ways.

Science P. 108.